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OF THE
G E O L O G I C A L S U R V E Y
OF
THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF
BRITISH ORGANIC REMAINS.

DECADE V.

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BRITISH FOSSILS.

DECADE THE FIFTH.

IN apologizing for the unavoidable delay which has taken place in the publication of this Decade, owing to the much lamented decease of Professor Edward Forbes, it is right to state that the materials left behind by him were scanty, and had been unfortunately mislaid a short time before his death. The first description only, that of *Solaster Moretonis*, had been fully written by him ; of the others, we had here and there notes on the distinctive characters of the species, and of his views as to their synonymy or history. The plates, however, had been all engraved under his own eye, and the specific designations under which he wished the figures to stand, were recorded in the last edition of Morris's Catalogue. He had there also applied MS. names to a number of species to be described in the Decade.

In a few cases only it has been found necessary to alter some of these names ; and this has been done in deference to an authority which would have been gladly admitted by Professor Forbes. To Mr. S. P. Woodward, of the British Museum, we are indebted for all the notes respecting these supplementary species ; and he has also furnished full descriptions of three of the plates. With this valuable aid, and the friendly communications of Dr. T. Wright, of Cheltenham, we can present the Decade in nearly as complete a form as it would have possessed had our friend and Master lived to finish it. We miss, however, his lively remembrance of the living species, and his practical acquaintance with their variations,—deficiencies not to be supplied by reference to his published works.

Of the ten species figured three are new,—*Solaster Moretonis*, *Cidaris Carteri*, and *Pygaster conoideus*. Of the other genera, *Diadema*, *Echinopsis*, and *Echinus* present us with well-known types from the Oolitic rocks, which are continental as well as British. *Pyrina* is a rare genus in England, and in this, and the two figured species of *Pygaster*, we have excellent examples of that division of the *Cassidulidae* in which the ambulacra are of uniform character throughout. Several genera of this type have been figured in the Decades. The *Pygaster semisulcatus* is a critical species, and its synonymy is now for the first time cleared up. *Hemaster Murchisoniae* is another instance of the same kind, and belongs to a large genus of closely allied species. The *Brissus Scillæ* is a Crag species still existing in the Mediterranean. None of these nine genera have before appeared in the Decades.

There are engraved plates sufficient for another fasciculus, upon which Professor Forbes left no memoranda, except the names of the species. These Plates will be published at a future period.

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Palæontologist.

Geological Survey Office, Jermyn Street, London,
February 1856.

BRITISH FOSSILS.

DECade V. PLATE VII.

PYGASTER SEMISULCATUS.

[Genus PYGASTER. AGASSIZ, 1834. (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Cassidulidae.) Orbicular, depressed or subconic; ambulacra simple throughout; tubercles perforate (and crenulate?), disposed in very regular series in both areas; anus very large, superior, generally placed near to the plates of the disk; mouth decagonal, no tubercles round it.]

DIAGNOSIS. *P. depressus, subpentagonus, margini postico subacuto, nec truncato; tuberculis conspicuis—primariis ambulacrorum supra binis, ad marginem in series 4—5—interambulacrorum 18—22—collocatis; basi in medio valde concavā: ano majori lateribus tumidis.*

SYNONYMS. *Clypeus semisulcatus*, PHILLIPS (1829), Geol. Yorksh. vol. i. p. 104. t. 3. fig. 17. (fig. two-thirds nat. size). BUCKMAN, in Murchison's Geology of Chelt., 2nd edit. p. 95. (1845). *Nucleolites semisulcatus*, DESMOULINS (1837), Tabl. Syn., p. 362. *Pygaster semis*, AGASSIZ, Prodri. Ech., p. 185. LAMARCK, Hist. Nat., 2nd edit. (1840), vol. iii. p. 353. WRIGHT, Ann. and Mag. Nat. Hist. (1852), vol. ix. p. 89. *Pygaster umbrella*, AGASSIZ, Ech. Suiss. (1839), tab. 13. fig. 1—3. DESOR (1842), Monogr. des Galerites, 3., p. 77. t. 12. fig. 4—6. FORBES, in Morris's Catalogue, 2nd edit. 88. (not *Galerites umbrella*, LAMARCK).

Description.—This fine Oolitic fossil is 3 inches across in either direction, and $1\frac{1}{2}$ inch in height. The general form is subhemispheric, and the outline orbicular or very slightly pentagonal. The base is flat and deeply concave at the mouth.

The upper surface is most generally evenly convex, more rarely the sides are flattened and the shape low-pyramidal. The vertex from which the five ambulacra radiate at nearly equal distances, is rather behind the centre, and as the large oblong anal opening* is close to the plates of the disk, which are (always?) lost, a broad keyhole-shaped cavity is left, which occupies the central and post-central portions.

* In the young state this opening is far less conspicuous.

The ambulacra are equidistant and of equal width, scarcely one-fourth as wide as the spaces between them. The three anterior ones are nearly direct, while the two posterior ones are a little bent out near their origin, to conform to the tumid edge of the large opening; in the ordinary varieties they are not at all elevated above the intervening spaces. They are composed of very numerous (about 150) pairs of plates, judging from the number of primary tubercles—one to about three plates—and from the pairs of pores.

The primary tubercles in the ambulacral area are in four* rows on the under surface and about halfway up the superior face, but only the outer rows continue to the vertex. These rows are placed along the margin close to the pores, and there are about fifty-six tubercles in each of them, of which thirty-six belong to the upper, and twenty-two to the under surface. They are small, perforate, and set upon but little elevated mamillæ, which are sometimes irregular or even slightly crenulate above, but often appear quite smooth under the lens.

The surface of the ambulacral and interambulacral spaces are occupied by small granules not very closely placed, and mixed with a few secondary tubercles, the areolæ of which are distinctly sunk. A single row of these granules separates each primary tubercle from its neighbour, and they form rather a loose circle round each areola.

The avenues are not sunk in any of the typical specimens, and the pores are ranked in single file, as usual in the genus. They are rather large, and each pair (corresponding to one of the three plates opposite each primary tubercle) consists of an inner *roundish* and an outer *oval* pore, the two being placed in somewhat opposite directions, and separated by a strong elevated tubercle.

The interambulacra have numerous rows of equal-sized tubercles similar to those of the ambulacra, with an areola distinctly depressed at the margin; they are larger, at least in the principal rows, than those of the ambulacra, and more distant, there not being above nineteen or twenty in a complete row on the upper surface, and fourteen or fifteen below. They are arranged in the following manner: two complete rows down the centre of the interambulacral plates extend from the vertex to the mouth, and on the inner side of these—first one, then two (see 4a), and near the margin even four, rows appear placed in regular transverse rows on the plates. Outside the principal rows an equal or greater number

* A fifth and, rarely, even a sixth, is interposed in some specimens at the actual margin, but not continued much above or below it.

of similar tubercles appear, but in loose order and not placed in regular line with the rest. Altogether about twenty rows (sometimes more) may be counted at or about the margin of an interambulacrum. On the under surface (fig. 3.), the transverse rows are very distinct, and the difference between the central and the exterior portions is particularly manifest. As the plates become square and less transverse near the mouth, the rows become more distant and irregular, till there are again (in the angles of the notches) only the two primary rows left. The tubercles there are of larger size than those represented in our fig. 3.

"The base is concave, and the mouth is central and placed in a considerable depression. It is of moderate size, about one-fifth the diameter of the test" in half-grown specimens, but less in the adult. It is ten angled, the notches equally deep, but in pairs nearer together beneath the interambulacrum than at the avenues.

The plates of the disk are absent in all our specimens. They appear, however, to have been depressed. From the figures given by Agassiz of the closely allied Swiss species, the disk must have been oblong, the two posterior lateral ovarian apertures being placed rather wide apart, and the hinder one absent. The anal aperture is very large, and in our specimens being confounded with the space left by the disk plates, its shape cannot be very well ascertained. It occupies in adult specimens full half the length of the odd interambulacrum, and appears to be oblong-oval rather than pyriform. Its sides are incurved, but the depression in which it lies does not extend further* than the anus itself, although the tumid ridge on each side of it continues for some way down. In young specimens the anal opening is very much smaller, and proportionally narrow. "The spines adhering to this specimen are short, needle shaped, and delicately striated." (Wright, l. c.)

Variations.—We have figured Dr. Wright's very fine specimen, which is unusually large and has the tubercles more conspicuous than common, nor has it any convexity in the ambulacra beyond what arises from their forming the angles of the pentagon. Other specimens from the same locality agree with it in nearly all respects, but have the tubercles of less size and more numerous, twenty-four in a row across the interambulacra, and as many as six at the

* This is one of the many characters in which our species differs from the bad figure of *Galerites umbrella*, given in the Encyc. Méthodique, and which has been quoted again and again by Agassiz as a synonym of his *Pygaster umbrella*, a species closely allied to the one here described.

ambulacral margin. If this variety had a truncated posterior margin it would be the *P. Morrisii*, Wright, a very closely allied species. In others the form is slightly more pentagonal, and in one extreme variety the form is as angular and the sides of the pyramid as flat, as in the species next to be described (*P. conoideus*). But the tubercles are large, not minute, and the ambulacra though elevated have not sunk avenues, as in that species. The base occasionally is not flat, but undulated, the interambulacra being tumid on the lower surface.

The variation observable in the young state, viz., that the anal opening is very small and narrow, has before been adverted to. Only the two primary rows of tubercles in each area show distinctly when the specimens are but half an inch across.

Affinities.—“*P. semisulcatus* most nearly resembles *P. umbrella*.* We have before us specimens which are well represented by Agassiz’s figure, but the loss of the tubercles from the Swiss specimen leaves the question of their identity an open one.” (Wright.) And we may add, that in the Swiss species the anal opening is larger and more pyriform, and the tumid ridge on either side of it is absent. But it appears to be present, to judge from the profile, in *P. patelliformis*, figured by Agassiz in the same plate (Ech. Suisses, tab. 13, f. 1-3.), a species in which we can scarcely see any character which should sufficiently separate it from *P. semisulcatus*, unless it be the breadth of the ambulacra and the continuation of their inner rows of tubercles higher up than in ours. The anus is certainly larger and seems to be pyriform rather than oval-oblong. This last difference may be sufficient to distinguish the two species, and it is accordingly inserted in the specific character. *P. laganooides*, Agass., figured in the same work, and in Desor’s Monograph, is even more like, especially in the form of the anus, which is also placed in a depression along with the plates of the disk. The greater breadth of the ambulacra, the larger size of the mouth, and the much closer and more regularly placed tubercles, however, prevent us from uniting it with ours. *P. tenuis* of Desor’s Monograph, tab. 12, f. 1-3., is so very like in the arrangement of the tubercles, narrow ambulacra, and sunk mouth, that but for the more depressed shape and large anal opening, which too, is not flanked by tumid ridges, it might be identical. It is from the Jura, in the “Terrain à Chailles.”

History.—The list of synonyms was all that was left regarding this species by Professor Forbes, and in deference to him the

* Now *P. dilatatus*, Ag., Cat. Raisonné, l. c., p. 144.

reference to *Galerites umbrella* of Lamarck would have been retained, but that there is evidently a mistake altogether about that species, which is a *Nucleolites*, and not a *Pygaster*; and the quoting of it at all by Agassiz was probably an accidental error, which has been copied by himself and others without looking to the original figure of Klein.* Lamarck's description indeed might probably be mistaken for that of a *Pygaster*, as he distinctly says "*sulcis ambulacrorum angustis biporosis*," but he adds, "*substriatis*," and the figure shows broad avenues with the pores connected by transverse furrows; in fact, it is much like some forms of the common *Nucleolites (Clypeus) patella*, though probably a distinct species.

Prof. Buckman's notice, in 1845, of *Clypeus ornatus*, from the Oolite of Cheltenham, recalls the general form and markings of the species, though his specimen, as usual, having lost the plates of the disk, he makes a mistake in supposing the anal opening to have been at the vertex, the broad sinus extending from it halfway downwards being the aperture in question.

"The figure given by Phillips in 1829 without a description is a mere outline, two-thirds the natural size, without details of structure, but sufficiently like for identification. It is said, at p. 104, to be common to the Coralline Oolite and Calc. Grit, in Yorkshire and Oxfordshire."—(Forbes.) Phillips' species was admitted by Desmoulins in his Catalogue of Echinoderms, and considered by him a *Nucleolites*. Agassiz, in his *Prodromus*, placed it in the genus *Pygaster*, under which name it has been included in the new edition of Lamarck (1840), and in Desor's 'Monograph of the Galerites' (1842). The latter author considered it (p. 76, 77) as probably the young state of the *P. umbrella*, not being aware that Phillips' figures were so much reduced. But he, strangely enough, quotes with it as synonyms of the *P. umbrella*, the old references given by Lamarck to the figures in the *Encyclopédie*, and those of Plott, Klein, and Leske, while he takes some pains in the text to show how wrongly it has been arranged as a *Nucleolites* by the side of the *N. patella*. This confusion has only been partly remedied by himself and Agassiz in the *Cat. Raisonné*, the reference

* It is remarkable that Agassiz should have repeated this mistake in rectifying the synonyms of *Pygaster* in the *Catal. Raisonné*. Klein's figure of *Clypeus sinuatus*, from a specimen in the Dresden Museum, is better than the copy in the *Encyc. Méthod.*, and shows the broad avenues more plainly. Leske compares it with the common English *Nucleolites*, which he calls *C. Plottii*, and says it has a more depressed form. They are apparently different species.

to *Galerites umbrella* still being retained for a French species of *Pygaster*, while the *P. umbrella* of the Ech. Suisses is altered to *P. dilatatus*. No mention is made of the *P. semisulcatus* of Phillips.

Dr. Wright, Annals Nat. Hist. for 1852, gave the first real description of the British species, distinguishing it carefully from the two other British forms, while with good reason expressing doubts as to its identity with the Swiss species, of which only a cast was published. In Morris's Catalogue, second edition, Professor E. Forbes adopted the present name, quoting Agassiz's *P. umbrella* only as a synonym. This course we are bound to follow in this Decade, for even if Agassiz's species should prove identical, it will be necessary to keep Phillips' name, since the old reference to Lamarck is undoubtedly erroneous.

Locality and Range.—GREAT OOLITE, Minchinhampton, Gloucestershire (Dr. Wright); Whitwell, Yorkshire, (in CALC. GRIT Phillips), but probably, "GREAT OOLITE" (Dr. Wright). See note at end of next description. INFERIOR OOLITE, Crickley Hill and Cheltenham, in the "Pea Grit," (Id. and Coll. Geol. Survey.)

FOREIGN DISTRIBUTION—doubtful. If *P. patelliformis* (*P. umbrella* of Agassiz) be identical, it occurs in the Kimmeridge Clay of the Jura Soleurois.

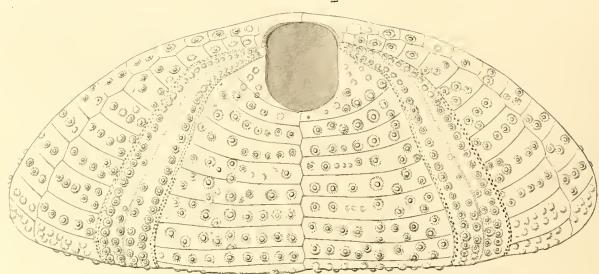
EXPLANATION OF PLATE VII.

Fig. 1. A fine specimen full grown, from the Inf. Oolite, Cheltenham, (Dr. Wright).
 Fig. 2. Posterior view of do., showing the four rows of ambulacral tubercles towards the margin.
 Fig. 3. Part of under side.
 Fig. 4. Plates and avenues, with pores in single file.
 Fig. 5, 6. Primary and secondary ambulacral tubercles, with the usual number of pores opposite to them. The pairs of pores are somewhat divergent.
 Fig. 7. Interambulacral tubercle, with its surrounding granules.
 Fig. 8. Side view of the same. The area is scarcely sunk enough round the margin, in this figure.

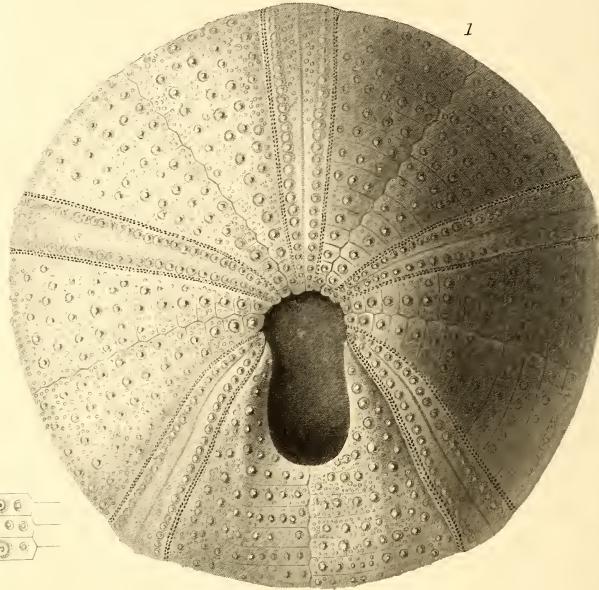
J. W. SALTER.

March 1856.

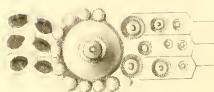
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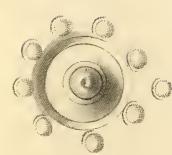
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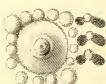
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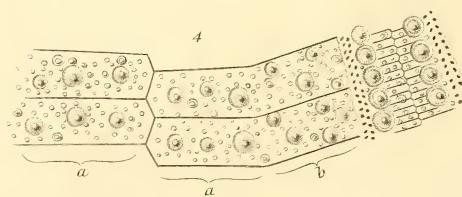
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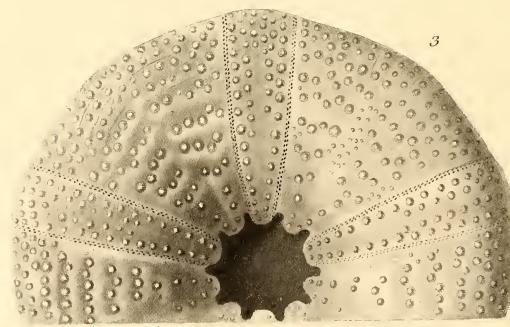
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PYGASTER SEMISULCATUS — Phillips.